Hidden entities and experimental practice: towards a two-way traffic between history and philosophy of science

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The significance of the philosophy of science for understanding historically scientific practice has not been sufficiently appreciated. Of course, the relationship between the history of science and the philosophy of science has been discussed extensively. The discussion, however, has been one-sided—occupied for the most part with the importance of the history of science for the philosophical understanding of science. Most commentators have viewed the history of science as a repository of empirical material for testing philosophical theories of scientific rationality or scientific change. On the other hand, there has been very little discussion of the ways in which the philosophy of science can enrich historiographical practice. Some authors have even denied that the philosophy of science has anything to offer to historians of science. Thomas Kuhn's words are characteristic: "I do not think current philosophy of science has much relevance for the historian of science" (Kuhn 1977, 12). Kuhn made that statement in the 1970s, but it captures the attitude of many historians ever since. The historians' skepticism towards the historiographical value of philosophy of science may have been justified, in view of some procrustean attempts to "apply" philosophical theories of scientific change to historical case studies. Nevertheless, as I have argued elsewhere, philosophy of science has a significant historiographical role: to analyze the philosophical presuppositions of historiographical categories (e.g., of scientific discovery) and choices (e.g., of the subject of a historical narrative). (See Arabatzis 2006.)

In this paper I want to carry this argument further, by examining how philosophical issues concerning experimental practice and scientific realism can enrich the historical investigation of the careers of "hidden entities", entities that are not accessible to unmediated observation. Entities of this kind have played a crucial role in the development of the sciences. Entire domains of theoretical and experimental practice have been structured around them. The history of the physical sciences abounds in examples: phlogiston and 18 th century chemistry, the subtle electric fluids and 18 th century experimental physics, caloric and the investigation of heat in the late 18 th and early 19 th centuries, the atom and 19 th century chemistry, the ether and 19 th century electromagnetic theory, and, last but not least, the various particles of 20 th century microphysics. This fact alone would suffice to render these entities historiographically significant. Furthermore, they are puzzling from a philosophical point of view. While they had been focal points of theoretical and experimental investigation, several of them turned out to be fictitious. For this reason, perhaps, the philosophical literature concerning these entities has focused on the problem of scientific realism, that is, on the grounds that we have for believing in their existence.

The questions I would like to explore in this paper are partly related to the problem of realism, but they also concern other aspects of experimentation on (and with) hidden entities. My starting point will be my recent work (Arabatzis 2006), where I have suggested that the experimental manifestations of hidden entities are crucial for establishing their identity and for constructing their theoretical representations. Here I would like to explore in a more systematic fashion the role of hidden entities in experimental practice, by examining the following inter-related questions:

For what reasons do scientists come to believe in the existence of a hidden entity? What kinds of evidence are brought to bear on the question of the existence of a hidden entity?

How do hidden entities function in experimentation and how does their detection, or even their constitution, depend on instrumentation?

Is experimentation on hidden entities a theory-driven enterprise or is it, at least partly, independent from high-level theory?

How is it possible to investigate experimentally the properties of entities that are not accessible to immediate observation?

What inferences lead from the experimental traces of these entities to their putative characteristics? To put it another way, what role does experimentally obtained information play in the construction of the representations of these entities?

How do experimentalists measure the properties of hidden entities and, thus, quantify their theoretical representations?

How are these entities identified in novel experimental situations?

How are they manipulated in the laboratory to probe other, less understood, aspects of nature?

Do they function as plastic resources, easily amenable to manipulation, or do they resist the experimentalists' attempts to manipulate them?

Can we make sense of experimentation on (or with) these entities without adopting a realist stance towards their ontological status? To put it another way, is it possible to understand experimental practice from a philosophical perspective that is neutral with respect to the realism debate?

I will argue that the investigation of these issues can profit from an integrated HPS approach. I will illustrate my analysis with examples from late 19 th century research on cathode rays.

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